

**Disclaimer: The views expressed are those of Paul Gipe and are not necessarily those of the sponsor.**

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# O&M Costs and Estimating Feed-in Tariff Payments

By Paul Gipe

Husum WindEnergy 2012



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Westmill Wind Cooperative, Oxfordshire, England

# Operating or “Running” Costs

- **Significant Cost**

Importance Should Not be Underestimated

- **Complex & Confusing**

No Standard as to What is Included

Operations & Maintenance

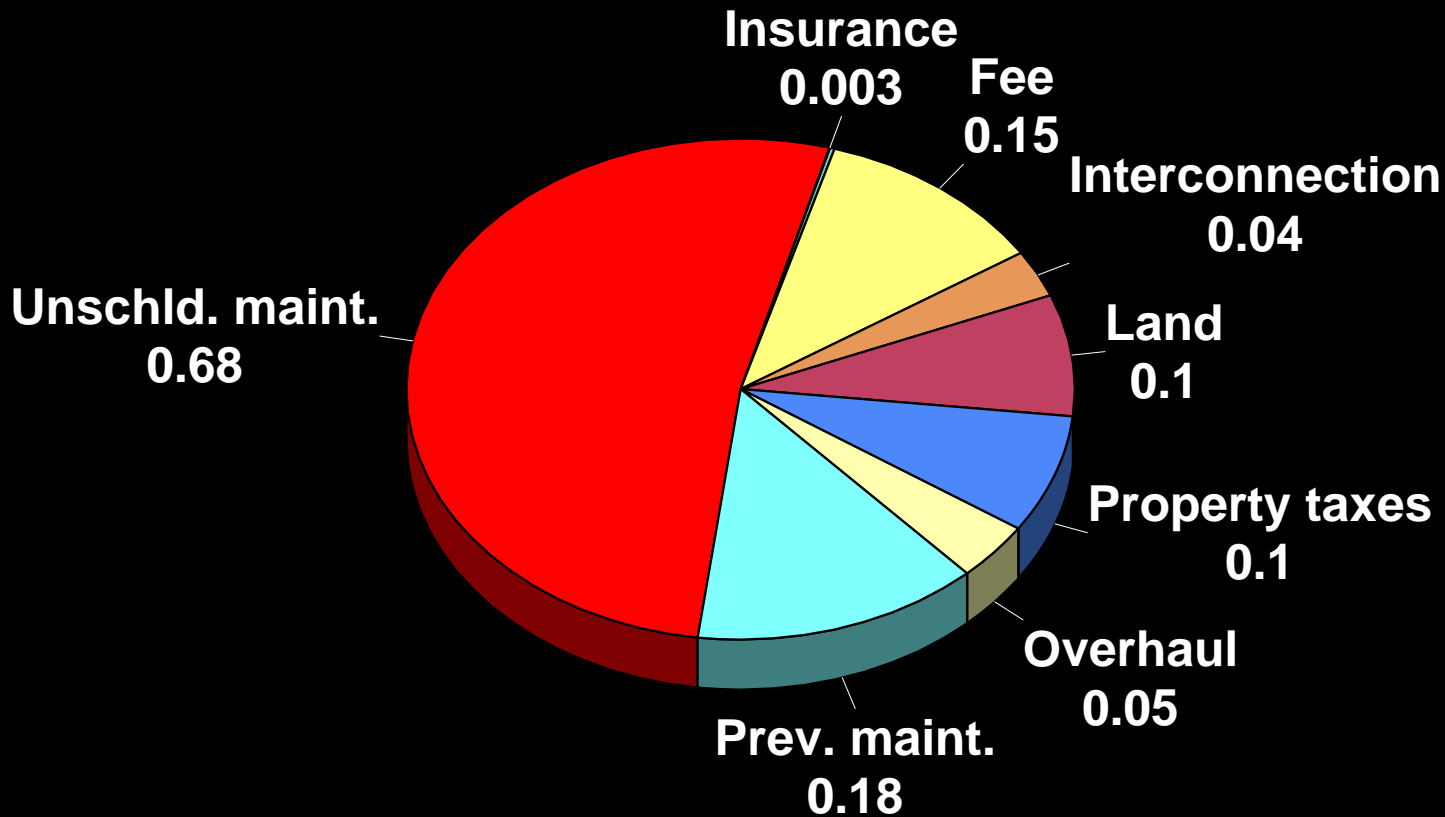
Insurance?

Lease or Royalty Payments?

Property Taxes?

# U.S. Operations & Maintenance Costs

@ 1.3¢/kWh



Source: NREL, 1997

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# Time-Varying Operating Costs

- Under Warranty-Out of Warranty
- First 10 Years-Second 10 Years
- Assumptions

Constant Value Year 1-20?

Inflating Value?

# Operations & Maintenance As Percentage of Total Investment

	Years 1-10	Years 10-20*
150-300 kW	1-3%	4-7%
500-600 kW	1-2%	4-5%

\*Includes prorated 20% reinvestment after year 10.  
Source: IEA, EMD 2001

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# Operating Costs Critical

- **To Profitable Operation**  
Over the Long Term
- **To Fair Feed-in Tariffs Payments**  
Fair to Operators  
Fair to Ratepayers

# Annual Reoccurring Expenses As a % of Total Investment

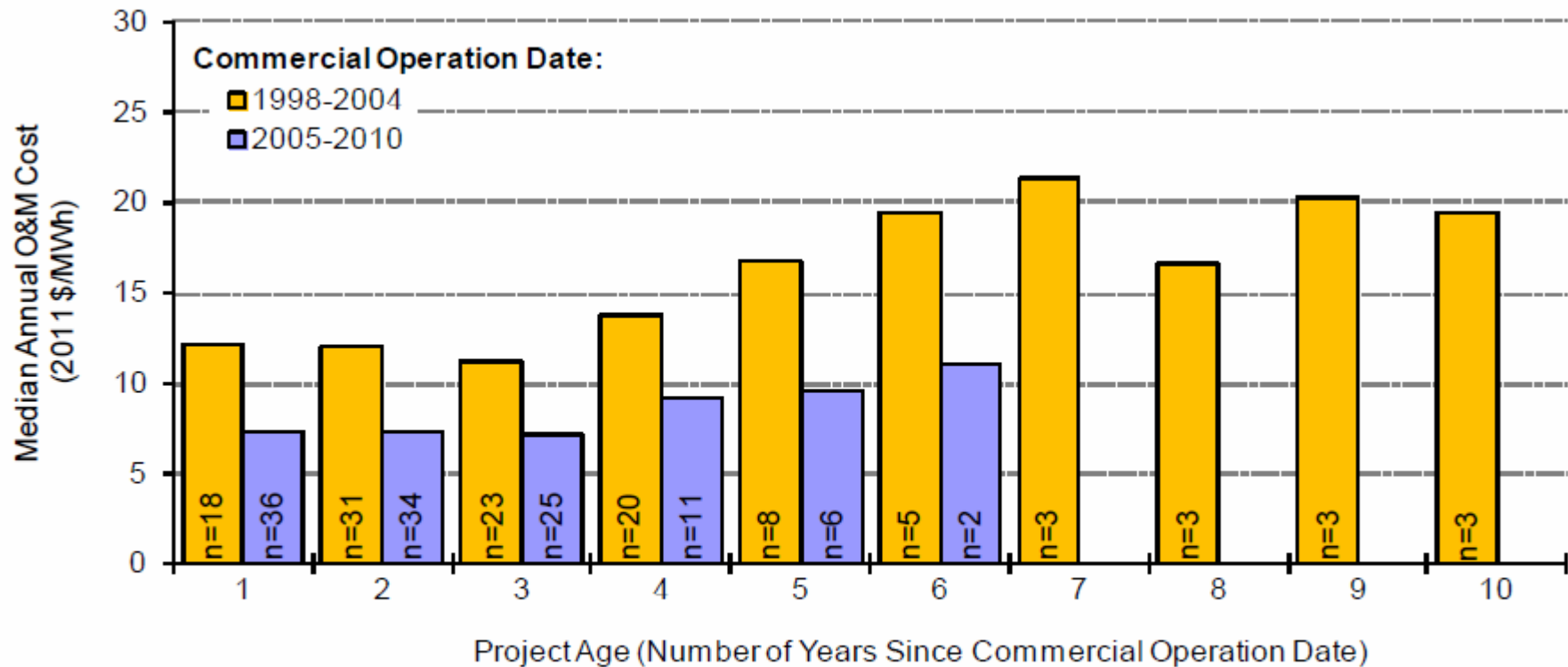
	Low	High
O&M	0.5%	1%
Repairs	1%	2%
Insurance	0.5%	1%
Lease	0.5%	1%
Management	<u>0.5%</u>	<u>1%</u>
Total	3%	6%

Adapted from Deutsche Windguard 2004

Paul Gipe, [wind-works.org](http://wind-works.org)



# US Operating Costs LBNL



Source: Berkeley Lab; medians shown only for groups of two or more projects, and only projects >5 MW are included

**Figure 25. Median Annual O&M Costs by Project Age and Commercial Operation Date**

# US Operating Costs LBNL

<b>GE Operating Costs 2012</b>		
Ryan Wiser Lawrence Berkeley NL		
Standard Turbine	1.6	MW
Operating Costs	\$60	\$/yr
Relative Installed Cost	\$1,850	\$/kW
O&M	3.2%	of Installed Cost
Low Wind Turbine	1.6	MW
Operating Costs	\$60	\$/yr
Relative Installed Cost	\$2,025	\$/kW
O&M	3.0%	of Installed Cost
<a href="http://eetd.lbl.gov/ea/ems/reports/wind-energy-costs-2-2012.pdf">http://eetd.lbl.gov/ea/ems/reports/wind-energy-costs-2-2012.pdf</a>		

# O&M Assumptions

## North American Feed-in Tariffs

- Nova Scotia ComFIT
- Hawaii Microgenerator FIT
- Ontario

Ontario Power Authority (Official)  
Green Energy Act Alliance

# Nova Scotia ComFIT Assumptions

Annual Operating Expenses Nova Scotia ComFIT By Synapse		
21-Feb-11		
Annual O&M	\$55,000	\$/yr
Insurance	\$21,000	\$/yr
Land Lease	\$16,200	3% of revenues.
Property Tax		
Assessed Value (%)	100%	
Assessed Value (\$)	\$2,885,000	
Property Tax Rate	0.3%	
Property Tax First Year	\$8,655	\$/yr
Total Project Cost	\$3,840,840	
Project Size	1,500	kW
Relative Cost	\$2,561	\$/kW
Generation	3,942,000	kWh/yr
<b>O&amp;M</b>	<b>1.4%</b>	of Installed Cost
<b>Insurance</b>	<b>0.5%</b>	of Installed Cost
<b>Land Lease</b>	<b>0.4%</b>	of Installed Cost
<b>Property Tax First Year</b>	<b>0.2%</b>	of Installed Cost
<b>Total</b>	<b>2.6%</b>	of Installed Cost

# Nova Scotia ComFIT Tariffs

## Nova Scotia Community-Based Feed-in Tariffs (ComFIT)

02-Sep-11

	Years	€/kWh	\$CAD/kWh	USD/kWh
Wind	20		1.24102	1.25141
<50 kW (<200 m <sup>2</sup> )		0.402	0.499	0.503
>50 kW		0.106	0.131	0.132

# Hawaii Microgenerator Assumptions

Hawaii 100 kW FIT Estimator		
O&M	\$5,400	\$/yr
Insurance	\$1,000	\$/yr
Property Tax	\$5,000	\$/yr
Project Size	100	kW
Total Installed Cost	\$675,000	
Relative Cost	\$6,750	\$/kW
O&M	0.8%	of Installed Cost
Insurance	0.1%	of Installed Cost
Property Tax	0.7%	of Installed Cost
Total	1.7%	of Installed Cost
Generation	208,000	kWh/yr

~5% of \$2,000/kW Installed Cost.

Paul Gipe, wind-works.org



# Hawaii Microgenerator FITs

Renewable Tariffs in Hawaii				
	2011 Years	Tariff €/kWh	1.24102 CAD/kWh	1.25141 USD/kWh
Wind				
<100 kW on all islands	20	0.110	0.137	0.138

# Ontario FIT Public Consultation

	Community	Onshore	Offshore
Typical Size (MW)	10	100	400
Construction Lead Time	1	2	3
Capacity Factor (%)	30	30	37
Capital Cost (\$/kW)	3,200	2,900 (2)	4,800 (1)
Fixed O&M (\$/kW/yr)	65	55 (1)	100 (3)

**Source:** (1) Energy Information Administration of the US Department of Energy, *Annual Energy Outlook 2009*.

(2) Cambridge Energy Research Associates, *Capital Costs Analysis Forum — Power: Market Review*, November 2008.

(3) Pace Global Energy Services, *Assessment of Florida Power & Light Energy Capital Cost Estimate*

# Ontario FIT Public Consultation

Ontario FIT Consultation 2009		
Onshore		
Project Size	100	MW
Relative Cost	\$2,900	\$/kW
Fixed O&M	55	\$/kW/yr
Fixed O&M	1.9%	of Installed Cost
Community Project		
Project Size	10	MW
Relative Cost	\$3,200	\$/kW
Fixed O&M	65	\$/kW/yr
Fixed O&M	2.0%	of Installed Cost
<a href="http://fit.powerauthority.on.ca/archive-apr7-session-info-fit-price-schedule-ie-technologies-size-and-prices">http://fit.powerauthority.on.ca/archive-apr7-session-info-fit-price-schedule-ie-technologies-size-and-prices</a>		

# Annual Reoccurring Expenses

## 2 MW Turbine North America

	'\$000 CAD	'\$000 CAD
O&M Years 1-10	\$60	\$60
Insurance	\$10	\$30
Land Lease	\$15	\$20
Communications	\$10	\$10
Snow Clearance!	\$0	\$10
Misc	<u>\$10</u>	<u>\$15</u>
Total	\$105	\$145

# Ontario FIT Calcs

## Chabot PI Method

### Tariff Calculation Using Chabot Profitability Index Method for Michigan

Adapted by Paul Gipe, pgipe@igc.org

Enter Data in These Cells.

#### Average Weighted Cost of Capital Before Tax

Equity		20%	
Return on Equity	ROE	13.0%	
Debt		80%	+1-C8
Interest on Debt		7.00%	
Nominal AWCC		8.2%	(\$C8*\$C9)+(\$C10*\$C11)
Inflation		3.0%	
AWCC real	t	5.0%	(C12-C13)/(1+C13)

Rotor Diameter	80	5,027	m2	((+B17/2)^2)*@PI
Rated Capacity		2,000	kW	
Specific Installed Cost	Ius	\$796	\$/m2	+C18/C17
Installed Cost	I	\$4,000,000		
		\$2,000	\$/kW	
Annual Expenses	Kom	4.0%		4%-6.8% of 70% (Deutsche WindGuard)
Term	n	20	years	
Discount Rate (AWCC)	t	5.0%	real	
Specific Yield	Eas	700	kWh/m2/y	
Capital Recovery Factor (n,t)	Kd	0.0806		(C22*(1+C22)^C21)/(((1+C22)^C21)-1)
Profitability Index Target	PI	0	NPV/I	
Cost of Energy	T1	\$0.137	\$/kWh	((1+C25)*C24+C20)*(C19/C23)
Simple Payback	SPBT	8.3	years	

Note: Before tax, 100% Adjustment with Inflation.

# Chabot PI Method

## Calculation of Constant Equivalent Tariff (Teq) and Tariff T2

### Example Only

			j	5.00	years
Term of Fixed Price, T1					
CRF During Fixed Price Period, j			CRF(t,j)	0.231	
			1/CRF	8.087	
			CRF(t,j)	0.124	
			Years 1-j		Years j-n
	Eas	T1	Teq		T2
	Yield				
	kWh/m2/y		\$/kWh	\$/kWh	
Target	<b>0.00</b>	<b>700</b>	<b>\$0.137</b>	<b>\$0.137</b>	<b>\$0.137</b>
	0.02	725	\$0.137	\$0.134	\$0.132
	0.04	750	\$0.137	\$0.131	\$0.128
	0.06	775	\$0.137	\$0.128	\$0.124
	0.08	800	\$0.137	\$0.126	\$0.120
	0.09	825	\$0.137	\$0.124	\$0.116
	0.11	850	\$0.137	\$0.121	\$0.113
	0.13	875	\$0.137	\$0.119	\$0.110
	0.15	900	\$0.137	\$0.117	\$0.107
	0.17	925	\$0.137	\$0.115	\$0.104
	0.19	950	\$0.137	\$0.114	\$0.101
	0.21	975	\$0.137	\$0.112	\$0.099
	0.22	1000	\$0.137	\$0.110	\$0.096
	0.24	1025	\$0.137	\$0.109	\$0.094
	0.26	1050	\$0.137	\$0.107	\$0.092
	0.28	1075	\$0.137	\$0.106	\$0.089
	<b>0.30</b>	<b>1100</b>	<b>\$0.137</b>	<b>\$0.105</b>	<b>\$0.087</b>
	0.30	1125	\$0.137	\$0.102	\$0.084
	0.30	1150	\$0.137	\$0.100	\$0.080
	0.30	1175	\$0.137	\$0.098	\$0.077
	0.30	1200	\$0.137	\$0.096	\$0.074

Tariff T2 is a linear interpolation between the values of Eas.



# Feed-in Tariff Calculations O&M Assumptions

- **Require Transparency**  
For Fairness to Owners & Ratepayers
- **Offer Transparency**
  - Germany
  - Great Britain (Microgenerator)
  - Ontario
  - Vermont
  - Nova Scotia
  - Hawaii

**“Nothing is as powerful as an idea  
whose time has come.”**

**-- Victor Hugo\***

Paul Gipe, [wind-works.org](http://wind-works.org)

**\*"Il n'est rien au monde d'aussi puissant qu'une  
idée dont l'heure est venue." Victor Hugo**



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